DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, D.C.

20332-5000

REPLY TO
ATTN OF:
LEEEU

SUBJECT: Coating Systems and Specifications for Exterior and Interior of Steel Tanks (Our ETL 86-4, dtd 12 May 86)

TO:

ALMAJCOM/DE	AFWL/NTE/NTC	HQ USAFA/DE	HQ AU/DE
AFIT/DE	AFDW/DE	AFRCE-WR	AFRCE-ER
AFRCE-CR	AFRCE-BMS	AFRCE-SAC	

Subject specifications were issued as attachment 1 to the referenced ETL and needs immediate revision. Request that you make the following pen and ink changes:

1. Paragraph 12.4.10.3.6.1 - Delete and replace with: "Mixing Ratio. The mixing ratio by volume of the MIL-P-24441 (Formula 159) is 1:4; for example, one gallon of component A (polyamide resin) to four gallons of component B (epoxy resin). Other MIL-P-24441 formulas are mixed one to one (1:1) by volume. NOTE: The individual A and B components of the various formulas are not interchangeable."

2. Paragraph 12.5.10.2.6.1 - (1) Insert "by volume" between "mixing rates" and "of the MIL-P-24441." (2) Delete "four gallons of component A to one gallon component B" and replace with "one gallon component A (polyamide resin) to four gallons component B (epoxy resin)."

cc: HQ AFESC/DEMM
ANG/DE
AFRES/DE

G. HAMMOND MYERS, III
Chief, Utilities Branch
Engineering Division
Directorate of Engineering & Services

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, D.C.
20332-5000

REPLY TO
ATTN OF:
LEEE

SUBJECT: Engineering Technical Letter (ETL) 86-4:
Paints and Protective Coatings

TO: ALMAJCOM/DE AFRCE-WR AFRCE-ER AFRCE-CR AFRCE-BMS AFRCE-SAC
HQ USAFA/DE AU/DE AFIT/DE AFDW/DE AFWL/NTE/NTC

1. Purpose. Provide specifications for surface preparation, coating systems, procedures and quality assurance for painting interior and exterior of steel tanks and structure.

2. This ETL:

a. Is mandatory per AFR 8-7, Engineering Technical Letters.

b. Supersedes ETL 86-3, dated 21 Feb 86.

c. Is effective immediately.

3. Referenced Publications. AFR 8-7, Air Force Engineering Technical Letters (ETLs); AFM 85-3, Paints and Protective Coatings; AFM 85-16, Maintenance of POL Tanks; AFR 88-15, Design Manual; NAVSEA 59086-VD-STM-000, Naval Ships Technical Manual Chapter 631; AFR 91-26, Maintenance and Operation of Water Supply, Treatment and Distribution Systems; AFR 127-12, Air Force Occupational Safety and Health Program.

4. Description Implementation. The coating systems contained in this ETL are high performance coating systems that will provide 10 years or longer service. These systems are the preferred systems for coating new steel tanks or when existing steel tanks or steel structures are abrasive blasted to bare steel. Sections contained in the ETL are:

Section 1. General Guidance for Use of Paints and Protective Coatings.

Section 2. Specifications for Coating System, Interior, Steel Tanks for Potable and Industrial Water.

Section 3. Specifications for Coating System, Interior, Steel Tanks for Petroleum Storage.

Section 4. Specifications for Coating System, Exterior, Steel Tanks for Petroleum Fuel Storage and Water Storage.

Section 5. Specification for Coating System, Steel Surfaces.

5. AFM 85-3 will be revised to include these coating systems.

6. Action officer for this ETL is Mr. Jesse R. Neal, AFESC/DEMM, Autovon 970-6342. Copies of this ETL may be obtained from this office.

FOR THE CHIEF OF STAFF

2 Atch
1. Specification
2. ETL Index

JARRELL S. MITCHELL, Colonel, USAF
Chief, Engineering Division
Directorate of Engineering & Services

cc: ANG/DE
AFRES/DE

ENGINEERING TECHNICAL LETTER (ETL) 86-4

COATING SYSTEMS AND SPECIFICATIONS FOR EXTERIOR AND INTERIOR OF STEEL TANKS

Section 1. GENERAL

12.1.1 SCOPE. This chapter covers approved coating systems including materials, surface preparation and application instructions, for Air Force facilities. The following specifications are included:

Section 2. Specification for Coating System, Interior, Steel Tanks for Potable Water and Industrial Water Storage;

Section 3. Specification for Coating System, Interior, Steel Tanks for Petroleum Fuel Storage;

Section 4. Specification for Coating System, Exterior Steel Surfaces, Steel Tanks for Petroleum Fuel Storage and Water Storage;

Section 5. Specification for Coating System for Steel Structures and Galvanized Repair

Appendix A. National Stock Numbers for MIL-P-24441 Coatings

12.1.2. GUIDANCE. This chapter Provides Guidance to Air Force personnel engaged in Project design and contract specification preparation. Appropriate portions of the individual

specifications in this chapter shall be included as part of the project design or contract specification rather than being referenced. However, general and technical notes contained in these specifications do not need to be part of the project design or contract specifications.

Specifications should not repeat information shown on drawings but should supplement the drawings by specifying the quality of materials and workmanship, methods of installation, equipment functions and testing required for the project.

12.1.3. HAZARDOUS MATERIALS. Paints, coatings and organic solvents may be hazardous to the environment or to personnel. Guidance for handling, use, application, storage and disposal are contained in Chapter 1 of AFM 85-3 and Air Force Regulations. The appropriate medical, safety and environmental safety personnel should be contacted if further guidance is required. All residuals and wastes must be disposed of in an environmentally safe manner and in accordance with all applicable federal, state, local and base laws and regulations.

Section 2

SPECIFICATION FOR COATING SYSTEM INTERIOR,
STEEL TANKS FOR POTABLE WATER AND
INDUSTRIAL WATER STORAGE

12.2.1 APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

12.2.1.1 Military Specifications:

MIL-B-131	Barrier Materials, Watervaporproof, Greaseproof, flexible, Heat-Sealable
MIL-P-3420	Packaging Materials, Volatile Corrosion Inhibitor Treated, Opaque
MIL-P-24441	Paint, Epoxy-Polyamide, General Specification for
MIL-P-23236	Paint coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast
MIL-C-2417b	Cement, Epoxy, Metal Repair and Hull Smoothing

12.2.1.2 Air Force Manuals and Regulations:

AFM 85-3	Protective Coatings Manual
AFM 85-16	Maintenance of Petroleum Systems
AFR 91-26	Maintenance and Operation of Water Supply, Treatment, and Distribution Systems.
AFR 127-12	Air Force Occupational Safety and Health Program

12.2.1.3 Federal Regulations: Occupational Safety and Health Administration (OSHA).

12.2.1.4 Steel Structures Painting Council (SSPC) Publications:
SSPC-SP 10 Near-White Metal Blast Cleaning
SSPC-Guide to Pictorial Vis 1 Surface Preparation
Standards for Painting Steel Surfaces

12.2.1.5 National Association of Corrosion Engineers (NACE) Publication:

Coating and Linings for Immersion Services,
Chapter 4, Inspection:

Condition "A"-Pinhole Free

Condition "B"-Relatively Pinhole Free

12.2.2 COATING SYSTEM DESCRIPTION-AREA TO BE COATED.
Abrasive blast steel as specified herein. The coating system shall be as specified in 12.2.9.1 Coat the tank interior including floors, side walls, support members, and roof. Apply coatings in lap seams. Tanks to be coated are existing tanks. Disposal of waste products including sludge, contaminated blasting abrasive, and water, and similar substances shall be done in accordance with AFM 85-16, Chapter 11.

12.2.2.1 Cathodic Protection System-Removal and Reinstallation
Water storage tanks should have cathodic protection systems installed in accordance with AFM 88-45 and maintained according to AFM 85-5. Before emptying tank the cathodic protection system should be turned-off, anodes and associated wiring carefully removed (see notes para 12.2.12) and stored in a manner that will preclude damage. Upon completion of the coating work, the cathodic protection system shall be reinstalled and tested in accordance with Corps of Engineers Guide Specification CEGS-16641 of June 1981.

12.2.3. MANUFACTURER'S CERTIFICATION.

12.2.3.1 Conformance Certification. Before delivery of the coating system to the job site, submit four copies of manufacturer's certificates of compliance attesting that the materials proposed for use meet the requirements specified.

12.2.3.2 Samples. Submit a 1 quart sample of each component to the Government agency designated by the contracting officer.

12.2.4 APPLICABLE MATERIALS

12.2.4.1 Primer. Epoxy-Polyamide, Green Primer, Formula 150 of MIL-P-24441.

12.2.4.2 Top Coat. Epoxy-Polyamide, White Topcoat, Formula 152 of MIL-P-24441.

12.2.4.3 Epoxy Cement. MIL-C-24176, Type II

12.2.4.4 Vapor-Tight Material. MIL-B-131 or MIL-P-3420

12.2.4.5 Abrasives. Abrasives for blasting shall be sharp, salt free, angular silica sand, crushed garnet, or steel grit free from constituents that tend to break down and remain on the surface. Particle size grading shall be such that all particles will pass a No. 20 sieve and be retained on a No. 40 sieve with no less than 40 percent retained on a No. 30 sieve.

12.2.5 COATING PRODUCTION, SAMPLING AND TESTING.

12.2.5.1 Qualified Products Listing Suppliers of MIL-P-24441 and MIL-C-24176 shall be listed on the current Qualified Products Listing (QPL) at the time of contract advertising.

12.2.5.2 Sampling of Coating Materials. The contractor shall notify the Contracting Officer when the material is available for testing and inspection at the source of supply.

12.2.5.3 Test of Coating Materials. Sample of each batch shall be taken during manufacture and tested in accordance with the applicable material specifications and FED-STD-141.

12.2.5.4 Test Reports. Test reports from each batch of material shall be forwarded to the Contracting Officer by the Contract Administration representative.

12.2.6 SAFETY. Cleaning of water storage tanks, including ventilation, and safety, shall be in accordance with AFOSH standards for cleaning and painting confined spaces and applicable OSHA standards.

12.2.7 SURFACE PREPARATION - GENERAL. Rough surfaces on weld seams, sharp edges, and corners shall be ground smooth, i.e., to a minimum of 1/8-inch radius. All surfaces shall be

abrasive blasted to near white metal in accordance with SSPC-SP 10. Prior to commencing blasting, a 12-inch square steel test plate shall be prepared for conditions selected in SSPC-Guide to Vis 1. The sample shall be submitted by the contractor for the approval of the Contracting Officer. The approved sample shall be used as a standard of comparison for the tank surfaces throughout the course of work. The test plate shall be kept carefully wrapped and sealed in vapor tight material complying with MIL-B-131 or MIL-P-3420 to prevent corrosion. Blasting equipment shall be conventional air, force feed or pressure type. Under no circumstances shall any type of water or vapor blast be permitted. The nozzle shall be of such size that a pressure of 90 +/- 10 psig will be maintained at the blast generator. The air supply shall be filtered and shall be free of oil and moisture. The blasting shall be done in sections or blocks small enough to permit application of the first coat of the organic coating system before corrosion starts. In all cases surface preparation and priming must be done the same day. The tank surfaces shall be abrasive blasted to match the prepared test plates. After abrasive blasting, the surfaces shall be thoroughly cleaned by brushing, blowing with oil and moisture-free compressed air or vacuuming. Sharp depressions or deep pits shall be welded and ground smooth; if this is not possible, epoxy cement shall be troweled into the pits or depressions and smoothed. The cement shall have a texture sufficient to permit tight bonding of the organic coating.

12.2.8 TEMPERATURE CONDITIONS - GENERAL. Abrasive blasting and coating operations shall be done only when the steel surfaces are between 35 and 110 deg. F (1.7 and 43 deg. C) and the temperature is at least 5 degrees Fahrenheit (deg. F) (2.8 degrees Centigrade (deg. C)) above the dew point of the surrounding air. This 5 deg. F (2.8 deg. C) differential is necessary to prevent condensation of moisture on the tank surface. If required dry, heated air shall be circulated through the tank to maintain temperature and humidity requirements and accelerate curing.

12.2.9 APPLICATION OF COATING SYSTEM.

12.2.9.1 General Procedures. The dry film thickness (DFT) of the coating system shall be as specified below. The complete coating shall be 8 to 10 mil DFT.

1st Coat - Formula 150 Epoxy-Polyamide Green Primer,
MIL-P-24441 - 2 to 4 mils DFT

2nd Coat - Formula 152 Epoxy-Polyamide White Topcoat,
MIL-P-24441 - 2 to 4 mils DFT

3rd Coat - Formula 150 Epoxy-Polyamide Green Primer,
MIL-P-24441 - 2 to 4 mils DFT

4th Coat - Formula 152 Epoxy-Polyamide white Topcoat,
MIL-P-24441 - 2 to 4 mils DFT

The first coat shall be applied as soon as possible after the blast cleaning. If visible rusting does occur after blasting, regardless of the time interval, the rusted surface shall be reblasted prior toapplying the specified primer. Prior to application of the first coat the surface shall be

inspected for conformance to SSPC-SP 10, near white metal blast cleaning. Temperature and dew point shall also be taken before applying the coating to ensure that specified conditions are met. All interior steel surfaces of the tank shall be coated including the bottom, shell, underside of the roof and all internal piping, roof legs (where applicable), and other internal appurtenances. Sharp edges and welds shall be brush coated before a full coat is applied by spraying. The epoxy-polyamide second, third and fourth coats shall be applied successively, allowing a drying time of not less than 48 hours nor more than 7 days between each coat. Each of the 4 coats shall have a dry film thickness of approximately 2 to 4 mils. The total dry film thickness (DFT) of the complete system shall be not less than 8 mils. If necessary to obtain the required minimum thickness of 8 mils, an additional topcoat shall be applied. Dry, heated air may be used for curing between coats. Ambient air temperature shall not exceed 100 deg. F (38 deg. C) during curing. All safety precautions shall be rigidly followed in all operations.

12.2.9.2 Instructions for Epoxy-Polyamide Coatings (MIL-P-24441).

12.2.9.2.1 Coating Description. Epoxy-polyamide coatings are similar to other epoxy coatings in that they consist of a two component system that includes a pigmented polyamide resin portion (A component) and an epoxy resin portion (B component).

Once they are mixed together and applied as a wet film, the coating cures to a hard film by chemical reaction of the epoxy and polyamide resins. During this curing period, the solvents used to maintain the composition in liquid form are released by evaporation.

12.2.9.2.2 Coatings Available. Epoxy-polyamide coatings (MIL-P-24441) consist of individual formulations, for example, Formulas 150 is for a green primer and Formula 152 is for a white topcoat. These coatings are suitable for use in or on fuel tanks, structural steel, water tanks (industrial and potable) and other high performance areas. Epoxy-polyamide coatings are available in l0-gallon, 2-gallon, and 2-quart kits. See Appendix A for list of Federal Stock Numbers.

12.2.9.2.3 Epoxy-Polyamide Coating Hazards. All MIL-P-24441 formulations have a minimum flash point of 95 deg. F (35 deg. C) and do not require the type of precautions against fire that are essential for faster drying vinyl paints. Since solvent fumes from epoxy paint systems are combustible and toxic, suitable precautions shall be taken to prevent their accumulations, particularly in confined spaces. Precautions against such hazards are contained in AFM 85-3 and AFM 85-16. In addition to fire and toxic hazards, epoxy coatings can cause allergic reactions when allowed to come in contact with the skin. Prompt skin cleanup after contact using soap and water, not solvents is recommended. Solvents will thin and spread the paint over the skin, p increasing the hazard of a delayed allergic reaction.

12.2.9.2.4 Surface Preparation. The single most important factor affecting the performance of the MIL-P-24441 epoxy-polyamide coatings is the preparation of the surface to be coated both as to method and quality of workmanship. Surfaces to be coated should be completely free from rust, loose paint, dirt, scale, oil, grease, salt deposits, moisture, and other contaminants. Surface preparation procedures detailed in 12.2.7 apply and are supplemented by requirements given below.

12.2.9.2.4.1 Bare Surfaces. When painted surfaces show evidence of corrosion, peeling, blistering, checking, or general disintegration, the old paint should be removed down to bare metal prior to repainting. Surfaces to be painted with the epoxy-polyamide system shall be abrasive blasted to near white metal. In areas where abrasive blasting is not permitted, the surfaces should be cleaned by mechanical means (disk sanding, chipping tools, or pneumatic descaler (needle gun)) to remove all loose paint film and foreign matter. Since abrasive blasting will not adequately clean surfaces contaminated with oil or grease, such areas should be cleaned with solvent prior to abrasive blasting.

12.2.9.2.4.2 Surface PreParation of Coated Metal. Brush abrasive blasting of existing paint may be used instead of blasting to bare metal in those instances where an epoxy coating is in good condition and tightly bonded. This method should result in a surface retaining a satisfactory paint film, but free from all rust, scale, and foreign matter that would inhibit the bonding of a topcoat.

12.2.9.2.5 Touch-up Painting. When only localized damaged areas or spots require painting, it is essential that removal of the deteriorated paint be carried back to an area of completely intact and tightly adhering paint film. Edges of tightly adhering paint remaining around the area to be recoated shall be sanded to a smooth slope (feathered) from the intact paint film to the bare metal area. Areas of intact paint to be overcoated shall first be roughened by light blasting or hand sanding and a 1 to 2 mils (WFT) tack coat applied before the full coat is sprayed.

12.2.9.2.6 Mixing Epoxy-Polyamide Coatings. Epoxy-polyamide coatings are supplied in measured amounts that must be mixed together in exact proportions to ensure the correct and complete chemical reaction. Mix no more paint than can be applied in the same day and discard any mixed paint remaining at the end of the day.

12.2.9.2.6.1 Mixing Ratio. The mixing ratios of the MIL-P-24441 coatings (except Formula 159), are 1:1 by volume; for example, 5 gallons of component A to 5 gallons of component B.

NOTE: The individual A and B components of the various formulas are not interchangeable.

12.2.9.2.6.2 Mixing Procedures. Each component shall be thoroughly stirred prior to mixing the components together. After mixing equal volumes of the two components, this mixture

shall again be thoroughly stirred until well blended. Induction time is defined as the time immediately following the mixing together of components A and B during which the critical chemical reaction period of these components is initiated until the mixture is ready to apply. This reaction period is essential to ensure the complete curing of the coating.

12.2.9.2.6.3 MIL-P-24441 Induction Times. The temperature of the paint components in storage should be measured to determine the induction time and the pot life. The job site application temperature will affect the time required for the paint to cure, and must be considered in estimating induction time, cure time, and the pot life. The batch size also effects these functions, five gallon batches will react faster than one gallon batches therefore, small batches should be used at temperatures above 100 deg. F. When the job site temperature is 35 to 60 deg. F (1.7 to 16 deg. C) it is essential that a 1 hour induction time occur in a warm area, about 70 deg. F (21 deg. C), before the mixed paint is taken to the job site. At 60 to 110 deg. F (16 to 43 deg. C) a 30 minute induction time should be used. To ensure that the reaction proceeds uniformly, the paint should be stirred periodically during its induction period. This prevents localized overheating or hot spots within the paint mixture. No induction time is required when volumetric mixing spray equipment with in-line heaters set at 70 to 80 deg. F (21 to 28 deg. C) is used.

12.2.9.2.7 Epoxy-Polyamide Coating Application. Epoxy-polyamide coatings, MIL-P-24441 may be applied by brushing, spraying, or dip application.

12.2.9.2.7.1 Thinning Application. Ordinarily MIL-P-24441 coatings are not thinned. If necessary, up to 1 pint of epoxy thinner for each gallon of mixed paint may be added if paint has thickened appreciably during cold temperature application or if necessary to improve application characteristics. When applied at the proper thicknesses, without thinning, these paints should have no tendency to sag.

12.2.9.2.7.2 Application Thickness. Unless otherwise specified, apply each coat of paint to produce approximately 2 to 3 mils dry film thickness (DFT). Application which yields in excess of 4 mils DFT should be avoided to prevent sagging.

12.2.9.2.7.3 Spray Application. MIL-P-24441 paints can be sprayed with conventional spray guns and normal spray-pot pressures. The spray gun should be equipped with a middle sized (D) needle, and nozzle setup. Both conventional and airless spray equipment are suitable for use. Volumetric mixing with in-line heaters may also be used.

12.2.9.2.8 Time Between Coats. If more than 7 days elapse between coats of the epoxy, the surface should be cleaned with water and detergent and rinsed clean with fresh water. If required, use solvents for grease and oil removal. The coat (1 to 2 mils wet film thickness (WFT)) of the last coat applied or Formula 150 should be reapplied to the cured coat and allowed to dry approximately 4 hours before application of the next full coat of the system.

12.2.9.2.9 Equipment Cleanup. Since epoxy paints cure by an internal chemical reaction, the mixed paint should not be allowed to remain in spray equipment for an extended period, especially in the sun or a warm area. The paint cures more rapidly at higher temperatures. When components A and B are mixed together, the pot life of the mixture (including the induction time) is 6 hours at 70 deg. F (21 deg. C). Pot life is longer at lower temperatures and shorter at temperatures above 70 deg. F (21 deg. C). Spray equipment should be cleaned after using by flushing and washing with epoxy thinner or aromatic hydrocarbon thinners (xylene or high flash point aromatic naptha). General cleanup is also done with these solvents. Brushes and rollers should be given a final cleaning in warm soapy water, rinsed clean with warm fresh water, and hung to dry.

12.2.10 FIELD TEST AND INSPECTIONS.

12.2.10.1 General. To ensure proper inspections, the contractor shall advise the Contracting Officer when the work in progress is at the various steps listed below:

Step	Action
Prior to preparation of tank(s) for cleaning and repair	Safety inspection specified in 12.2.6
After cleaning of tank(s) and prior to abrasive blasting	Safety inspection, removal of dirt, trash debris, and any hindrance to abrasive blasting

After abrasive blasting	Surface inspection for compliance with the specified standard SSPC-SP 10 and 12.2.7
During and after coating application	Coating application inspection specified in 12.2.9 and 12.2.10.2
After final cleanup	Clean up inspection specified in 12.2.11.

12.2.10.2 Final Inspection. Following completion and cure of the coating system, the surfaces shall be carefully inspected by the contractor for pinholes, blisters, inadequate coating thickness, and other defects. All imperfections found that deviate from the specification shall be repaired by the contractor. The dry film thickness shall be measured by the contractor using a calibrated magnetic gage at 10 equally spaced points within a designated 10-foot by 10-foot area. The highest and lowest values shall be discarded and an average of the remaining 8 values shall be taken as the coating thickness. If the average is less than the specified minimum dry film thickness, additional readings shall be taken in adjacent areas to define the extent of the thin area. Such areas shall be recoated with the top coat as necessary to achieve the specified thickness. The recoating shall be within the time period specified in 12.2.9.1. Any coated areas that exceed 7 days shall be prepared and coated as specified in 12.2.9.2.8. The coating system shall be inspected for film

imperfections using a low voltage (75 volts direct current (VDC) or less) wet sponge holiday detector or an approximately 1440 VDC detector with a conductive silicone brush electrode. A distinctly audible signal on these detectors will sound to indicate imperfections caused by current flowing though the coating to the base metal. Imperfections shall be corrected by touch-up. No holidays or pinholes shall be allowed over welds, and these areas shall conform to NACE Condition "A" (refer to 12.2.1.3). All other areas shall conform to Condition "B" or "A" with Condition "B" defined as no more than one point of discontinuity in any 10 square foot area. After the work has been inspected and approved, the tank shall be rinsed at least twice and disinfected according to AFR 91-26 and a fill test shall be done at least 7 days after the final coat has been applied. The contractor shall remove the blind flanges and reconnect all piping to make the tank ready for service. The leveling float shall be reinstalled. The cathodic protection system shall be reinstalled in accordance with Corps of Engineers Guide Specification CEGS-16641 of June 1981, and after filling the tank the cathodic protection system shall be tested in accordance with CEGS-16641. The Government will provide the necessary water and labor to fill the tank. The contractor shall advise the Contracting Officer, in writing, at least 10 days in advance of the need for this service. After the temperature of the water has become stabilized, daily readings of the water level shall be made for a period of 10 days. If there is no measurable drop in the liquid level during this period, the tank will be accepted and will remain

in service. If leakage becomes apparent during the filling or the test period, the Contracting Officer shall be immediately notified. Then Government personnel will pump the water from the tank. The contractor shall then carefully inspect the new coating systems for evidence of failures. All defects found shall be repaired by the contractor and the fill tests repeated as part of the work.

12.2.11 FINAL CLEANUP. Following completion of the work, the contractor shall remove all debris, equipment, and materials from the site. Temporary connections to Government furnished water and electrical services shall be removed. All existing facilities in and around the work areas shall be restored to their original condition.

12.2.12 NOTES. (This section shall not be included in contract specifications). Before finalization of the specifications for maintaining or repair of the cathodic protection system, the system should be tested and inspected to determine which components should be replaced and reinstalled. Normally the header cable to which anodes are attached should be replaced. Testing, adjusting, and placing in service shall be in accordance with Corps of Engineers Guide Specification CEGS-16641, June 1981.

Section 3

SPECIFICATION FOR COATING SYSTEM, INTERIOR, STEEL TANKS FOR PETROLEUM FUEL STORAGE

12.3.1 APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

12.3.1.1 Federal Standard:

FED-STD-141	Paint, Varnish, Lacquer and Related Materials, Methods of Inspection, Sampling.

12.3.1.2 Military Specifications:

MIL-B-131	Barrier Materials, Watervaporproof. Greaseproof, Flexible, Heat-Sealable
MIL-P-3420	Packaging Materials, Volatile Corrosion Inhibitor Treated, Opaque
MIL-P-23236	Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast
MIL-P-24441	Paint, Epoxy-Polyamide, General Specification for

12.3.1.3 Air Force Manuals and Regulations:

AFM 85-3	Paints and Protective Coatings
AFM 85-16	Maintenance of Petroleum Systems
AFR 127-12	Air Force Occupational Safety and Health Program

12.3.1.4 Federal Regulations:

Occupational Safety and Health Act (OSHA)

12.3.1.5 Steel Structures Painting Council (SSPC) Publications:

SSPC-SP 10	Near White Metal Blast Cleaning
SSPC-Guide to Vis 1	Pictorial Surface Preparation Standards for Painting Steel Surfaces

12.3.1.6 National Association of Corrosion Engineers (NACE) Publication:

Coatings and Linings for Immersion Services, Chapter 4, Inspection:

Condition "A" Pinhole Free

Condition "B" Relatively Pinhole Free

12.3.2 COATING SYSTEM DESCRIPTION-AREAS TO BE COATED. See 12.3.13 for specific areas to be coated for various tank configurations. For additional guidance contact command or HQ AFESC/DEMM POL Engineer. Abrasive blast steel as specified herein. The coating system shall be as specified in 12.3.10.1.

12.3.3 MANUFACTURER'S CERTIFICATION.

12.3.3.1 Conformance Certification. Before delivery of the coating materials to the job site, submit 4 copies of manufacturer's certificates of compliance attesting that the materials proposed for use meet the requirements specified.

12.3.3.2 Samples. Submit a 1 quart sample of each component to the government agency designated by the Contracting officer.

12.3.4 GOVERNMENT FURNISHED MATERIALS AND SERVICES. The contractor shall provide material and services in accordance with the General Provisions of the contract except the Government will furnish, without cost, all test fuel products for leakproof testing of coated tanks as specified in 12.3.11.2 and the electricity necessary for use in performing this work.

12.3.5 APPLICABLE MATERIALS.

12.3.5.1 Primer. Epoxy-Polyamide, Green Primer, Formula 150 of MIL-P-24441.

12.3.5.2 Top Coat. Epoxy-Polyamide, Haze Gray Topcoat, Formula 151 of MIL-P-24441.

12.3.5.3 Top Coat. Epoxy-Polyamide, White Topcoat, Formula 152 of MIL-P-24441.

12.3.5.4 Epoxy Cement. MIL-C-24176, Type II

12.3.5.5 VaPor-Tight Material. MIL-B-131 or MIL-P-3420

12.3.5.6 Abrasives. Abrasives for blasting shall be sharp, washed, salt free, angular silica sand, crushed garnet, or slag, free from feldspar or other constituents that tend to break down and

remain on the surface. Particle size grading shall be such that all particles will pass a No. 20 sieve and be retained on a No. 40 sieve with not less than 40 percent retained on a No. 30 sieve.

12.3.6 COATING PRODUCTION, SAMPLING AND TESTING

12.3.6.1 Qualified Products Listing. Suppliers of MIL-P-24441 and MIL-C-24176 shall be listed on the current Qualified Products Listing (QPL) at the time of contract advertising.

12.3.6.2 Sampling of Coating Materials. The contractor shall notify the Contracting Officer when the material is available for testing and inspection at the source of supply.

12.3.6.3 Test of Coating Materials. Sample of each batch shall be taken during manufacture and tested in accordance with the applicable material specifications and FED-STD-141.

12.3.6.4 Test Reports. Test reports from each batch of material shall be forwarded to the Contracting Officer by the Contract Administration representative.

12.3.7 TANK CLEANING, SAFETY, AND FUEL REMOVAL. Cleaning of storage tanks, including ventilation, fuel removal and safety, shall be in accordance with AFM 85-16, Chapter 11.

12.3.8 SURFACE PREPARATION - GENERAL. Rough surfaces on welded seams, share edges, and corners shall be grounded smooth, i.e., to a minimum of a 1/8-inch radius. Surfaces specified in 12.3.2 shall be abrasive-blasted to near white metal in

accordance with SSPC-SP 10. Prior to commencing blasting, a 12-inch square steel test-plate shall be prepared using asection of existing tank surface or a sandblasted steel platefor conditions selected in SSPC-Guide to Vis 1. The sample shall be submitted by the contractor for the approval of the Contracting Officer. The approved sample shall be used as astandard of comparison for the tank surfaces throughout thecourse of work. The test plate shall be kept carefully wrappedand sealed in vapor-tight material for corrosion protection complying with MIL-B-131 or MIL-P-3420. Blasting equipment shall be conventional air, force-feed or pressure type. Under no circumstances shall any type of water or vapor blast be permitted. The nozzle shall be of such size that a pressure of 90 +/- 10 psig will be maintained at the blast generator. The air supply shall be filtered and shall be free of oil and moisture. The tank surfaces shall be abrasive blasted as required to match the prepared test plates. After abrasive blasting, the surfaces shall be thoroughly cleaned by brushing, blowing with oil and moisture-free compressed air, orvacuuming. Sharp depressions or deep pits shall be welded and ground smooth; if this is not possible, epoxy cement shall be trowelled in and smoothed. The cement shall have a texture sufficient to permit tight bonding of the coating system.

12.3.9 TEMPERATURE CONDITIONS--GENERAL. Abrasive blasting and coating operations shall be done only when the steel surfaces are between 35 and 110 deg. F (1.7 and 43 deg. C) and the temperature is at least 5 degrees Fahrenheit, deg. F (2.8 degrees

Centigrade, deg. C) above the dew point temperature of the surrounding air. This 5 deg. F (2.8 deg. C) differential is necessary to prevent condensation of moisture on the tank surface. If required, dry, heated air shall be circulated through the tank to maintain temperature and humidity requirements and accelerate curing.

12.3.10 APPLICATION OF COATING SYSTEM.

12.3.10.1 General. The Dry film thickness (DFT) of coating system shall be as specified below. The complete coating system shall be 8 to 10 mils DFT.

1st Coat - Formula 150 Epoxy-Polyamide Green Primer, MIL-P-24441 - 2 to 4 mils DFT

2nd Coat - Formula 151 Epoxy-Polyamide Haze Gray Topcoat, MIL-P-24441 - 2 to 4 mils DFT

3rd Coat - Formula 152 Epoxy - Polyamide White Topcoat, MIL-P-24441 - 2 to 4 mils DFT

12.3.10.2 General Procedure. The first coat, Formula 150 green primer, shall be applied as soon as possible after the blast cleaning and always the same day. If visible rusting does occur after blasting, regardless of the time interval, the rusted surface shall be reblasted prior to applying the specified primer. All interior steel surfaces of the tank shall be coated including the bottom, shell, underside of the

roof and all internal piping, roof legs (where applicable), and other internal appurtenances. The coating system shall be applied by experienced applicators. All welds, lap seams, reinforcing beams and sharp edges shall be brush painted before spray painting of each coat of paint over the entire tank interior. The epoxy intermediate, formula 151, and top coat, Formula 152, shall be applied successively allowing a drying time of not less than 16 hours nor more than 7 days between each coat. Each of the 3 coats shall have a dry film thickness of approximately 3 mils. The total dry film thickness of the complete system shall be not less than 8 mils. If necessary to obtain the required minimum thickness of 8 mils, an additional topcoat of Formula 152 shall be applied.

12.3.10.3 Instructions for Epoxy-Polyamide Coating (MIL-P-24441).

12.3.10.3.1 Coating Description. Epoxy-polyamide coatings are similar to other epoxy coatings in that they consist of a two component system that includes a pigmented polyamide resin (A component) and an epoxy resin portion (B component). Once they are mixed together and applied as a wet film, the coating cures to a hard film by chemical reaction of the epoxy and polyamide resins. During this curing period, the solvents used to maintain the composition in sprayable form are released by evaporation.

12.3.10.3.2 Coatings Available. Epoxy-polyamide coatings (MIL-P-24441) consist of individual formulations, for example, Formula 150 is for a green primer. These coatings are suitable for use in or on tanks, structural steel, wat (industrial and potable) and other high performance areas. Epoxy-polyamide coatings are available in l0-gallon, 2-gallon, and 2-quart kits. See Appendix A for list of Federal Stock Numbers.

12.3.10.3.3 Epoxy-polyamide Coating Hazards. All MIL-P-24441 formulations have a minimum flash point of 95 deg. F (35 deg. C) and do not require the type of precautions against fire that are essential for faster drying vinyl paints. Since solvent fumes from epoxy paint systems are combustible and toxic, suitable precautions shall be taken to prevent their accumulations, particularly in confined spaces. Precautions against such hazards are contained in Chapter 3 of this manual and in AFM 85-16. In addition to fire and toxic hazards, epoxy coatings can cause allergic reactions when allowed to come in contact with the skin. Prompt skin cleanup after contact using soap and water, not solvents, is recommended. Solvents will thin and spread the paint over the skin, permitting deeper penetration and increasing the hazard of a delayed allergic reaction.

12.3.10.3.4 Surface Preparation. The single most important factor affecting the performance of the MIL-P-24441 epoxy-polyamide coatings is the preparation of the surface to

be coated both as to method and quality of workmanship. Surfaces to be coated should be completely free from rust,loose paint, dirt, scale, oil, grease, salt deposits, moisture, and other contaminants. Surface preparation procedures detailed in 12.3.8 apply and are supplemented by requirements below.

12.3.10.3.4.1 Old Painted Surfaces. When painted surfaces show evidence of corrosion, peeling, blistering, checking, or general disintegration, the old paint should be removed down to bare metal prior to repainting. Surfaces to be painted with the epoxy polyamide system shall be abrasive blasted to near-white metal. In areas where abrasive blasting is not permitted, the surfaces should be cleaned by mechanical means: disk sanding, chipping tools, or pneumatic descaler (needle gun), to remove all loose paint film and foreign matter. Since abrasive blasting will not adequately clean surfaces contaminated with oil or grease, such areas should be cleaned with epoxy thinner specified in 12.3.10.3.8.1.

12.3.10.3.4.2 Surface Preparation of Coated Metal. Brush abrasive blasting of existing paint may be used instead of blasting to bare metal in those instances where an epoxy coating is in good condition and is tightly bonded. This method should result in a surface retaining all satisfactory paint films, but free from all rust, scale and foreign matter that would inhibit bonding of a topcoat.

12.3.10.3.5 Touch-up Painting. When only localized damaged areas or spots require painting, it is essential that removal of the deteriorated paint be carried back to an area of completely intact and tightly adhering paint film. Edges of tightly adhering paint remaining around the area to be recoated shall be sanded to a smooth slope (feathered) from the intact paint film to the bare metal area. Areas of intact paint to be overcoated shall first be roughened by brush abrasive blasting as described in 12.3.10.3.4. A tack coat shall then be applied as described in 12.3.10.3.8.4

12.3.10.3.6 Mixing Epoxy-Polyamide Coatings. Epoxy-polyamide coatings are supplied in measured amounts that must be mixed together in exact proportions to ensure the correct and complete chemical reaction. Mix no more paint than can be applied in the same day and discard any mixed paint remaining at the end of the day.

12.3.10.3.6.1 Mixing Ratio. The mixing ratios of the MIL-P-24441 coatings (except Formula 159) are 1:1 by volume, for example, 5 gallons of component A to 5 gallons of component B.

NOTE: The individual A and B components of the various formulas are not interchangeable.

12.3.10.3.6.2 Mixing Procedures. Each component shall be thoroughly stirred prior to mixing the components together. After mixing equal volumes of the two components, this mixture shall again be thoroughly stirred until well blended. The induction time shall be adhered to. Induction time is defined as that time immediately following the mixing together of components A and B during which the critical chemical reaction period of these components is initiated until the mixture is ready to apply. This reaction period is essential to ensure the complete curing of the coating.

12.3.10.3.7. MIL-P-24441 Induction Times. The temperature of the paint components in storage should be measured to determine the induction time and the pot life that might be expected. The job site application temperature will affect the time required for the paint to cure, and must be considered in estimating induction time, cure time, and the effect of batch size on these functions. No induction time is required when volumetric mixing spray equipment with in-line heaters set at 70 to 80 deg. F (21 to 28 deg. C) is used. When the epoxy MIL-P-24441 paints are to be applied at a job site having temperatures in the range of 35 to 60 deg. F, (1.7 to 15 deg. C), it is essential that induction occur in a warm area, about 70 deg. F (21 deg. C). An induction time of one hour should be used at this temperature. This ensures that the coating will fully cure. When the induction period is completed, the paint is then

carried to the job site. At temperatures from 60 to 110 deg. F (15 to 43 deg. C) a 30 minute induction time should be used. To ensure that the reaction proceeds uniformly, the paint should be manually stirred periodically during its induction period. This prevents localized overheating or hot spots within the paint mixture.

12.3.10.3.8 Epoxy-Polyamide Coating Application. Epoxy-polyamide coatings, MIL-P-24441, may be applied by brushing, spraying, or dip application.

12.3.10.3.8.1 Thinning Application. Ordinarily MIL-P-24441 coatings are not thinned. If necessary, up to one pint of epoxy thinner for each gallon of mixed paint may be added if paint has thickened appreciably during cold temperature application, or if necessary to improve application characteristics. When applied at the proper thicknesses, without thinning, these paints will have no tendency to sag.

12.3.10.3.8.2 Application Thickness. Unless otherwise specified, apply each coat of paint to produce approximately 3 mils dry film thickness (DFT). Application which yields in excess of 4.0 mils DFT should be avoided to prevent sagging.

12.3.10.3.8.3 Spray Application. MIL-P-24441 paints should be sprayed with the conventional spray guns and normal spray-pot pressures. The spray gun should be equipped with a middle-sized (D) needle, and nozzle setup. Both conventional and airless spray equipment are suitable for use. Volumetric mixing equipment with in-line heaters may also be used.

12.3.10.3.8.4 Time between Coats. If more than 7 days elapse between coats of epoxy, the surface should be cleaned with water and detergent and rinsed clean with fresh water. If required, use solvents for grease and oil removal. Then a tack coat (1 to 2 mils wet film thickness, (WFT)) of the last coat applied or Formula 150 should be reapplied to the cured epoxy coat and allowed to dry approximately 4 hours before application of the next full coat of the system.

12.3.10.3.9 Equipment Cleanup. Since epoxy paints cure with time by chemical reaction, the mixed paint should not be allowed to remain in spray equipment for an extended period, especially in the sun or a warm area. The paint cures more rapidly at higher temperatures. When components A and B, are mixed together, the pot life of the mixture (including the induction time) is 6 hours at 70 deg. F (21 deg. C). Spray equipment should be cleaned after using by flushing and washing with epoxy thinner or aromatic hydrocarbon thinners (xylene or high flash aromatic naptha). General cleanup is also done by using these solvents. Brushes and rollers should be given a final cleaning in warm soapy water, rinsed clean with warm fresh water, and hung to dry.

12.3.11 FIELD TEST AND INSPECTION.

12.3.11.1 General. To ensure proper inspection, the contractor shall advise the Contracting Officer when the work in progress is at the various steps listed below:

Step	Action
Prior to preparation of tank(s) for cleaning and repair	Safety inspection specified in 12.3.7
After cleaning of tank(s) and prior to abrasive blasting	Safety inspection, removal of dirt, trash debris, and any hindrance to abrasive blasting
After abrasive blasting	Surface inspection for coating application as specified in 12.3.10
During and after coating application	Coating application inspection specified in 12.3.10 and 12.3.11.2
After final cleanup	Cleanup inspection specified in the paragraph 12.3.12

12.3.11.2 Final Inspection. Following completion and cure of the coating system, the surfaces shall be carefully inspected by the contractor for pinholes, blisters, inadequate coating thickness, and other defects. All imperfections found that deviate from the specification shall be repaired by the contractor. The dry film thickness shall be measured by the contractor using a calibrated magnetic gage at 10 equally spaced points within a 10-foot by 10-foot area as designated. The highest and lowest values shall be discarded and an average of the remaining eight values shall be taken as the coating thickness. If the average is less than the specified minimum dry film thickness, additional readings shall be taken in adjacent areas to define the extent of the thin area. Such areas shall be recoated with the top white coat as necessary to achieve the specified thickness. The recoating shall be within the time period specified in 12.3.10. Any coated areas that exceed 7 days shall be lightly abrasive brush blasted or hand sanded to remove the glossy surface before applying the additional top coat. The coating system shall be inspected for film imperfections using a low voltage (75 volts direct current (VDC) or less) wet sponge holiday detector or an approximately 1440 VDC detector with a conductive silicone brush electrode. A distinctly audible signal on these detectors will sound to indicate imperfections caused by current flowing through the coating to the base metal. Imperfections shall be corrected by

touch-up. No holidays or pinholes shall be allowed over welds and over the bottom area and these areas shall conform to NACE Condition "A" (refer to 12.3.1.6). All other areas shall conform to Condition "B" or "A" with Condition "B" defined as no more than one point of discontinuity in any 10 square foot area. After the work has been inspected and approved, the tank shall be fill tested. The fill test shall not be done until at least 13 days after the final coat has been applied. The contractor shall remove the blind flanges and reconnect all piping to make the tank ready for service. The leveling float shall be reinstalled. The Government will provide the necessary fuel and labor to fill the tank with fuel. The Contractor shall advise the Contracting Officer, in writing, at least 10 days in advance of the need for this service. After the temperature of the fuel has become stabilized, daily readings of the fuel level shall be made for a period of 10 days. If there is no measurable drop in the fuel level during this period, the tank will be accepted and will remain in service. If leakage becomes apparent during the filling or during the test period, the Contracting Officer shall be immediately notified. Then Government personnel will pump the fuel from the tank. The contractor shall free the tank of vapor, clean it, and then carefully inspect the new coating system for evidence of failures. All defects found shall be repaired by the contractor and the fill tests repeated as part of the work.

12.3.12 FINAL CLEANUP. Following completion of the work, the contractor shall remove all debris, equipment, and materials from the site. Temporary connections to Government furnished water and electrical services shall be removed. All existing facilities in and around the work areas shall be restored to their original condition.

12.3.13 NOTES. (This section should not be included in contract specifications.)

12.3.13.1 Areas To Be Coated. Selection of areas to be coated (see 12.3.2) should be completed by the responsible base engineer. It should state specific interior areas to be coated based on inspection of the actual tank, its drawings, and specifications. All steel walls, floors, stanchions supports, piping and fixed on movable steel roofs should be coated. Do not coat aluminum roofs or covers.

Section 4

SPECIFICATION FOR COATING SYSTEMS, EXTERIOR
STEEL TANKS FOR PETROLEUM FUEL STORAGE AND WATER STORAGE

12.4.1 APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

12.4.1.1

Federal Standard:

FED-STD-595	Color (Requirements for Individual Color Chips)
FED-STD-141	Paint Varnish, Lacquer and Related Materials, Method of Inspection, Sampling and Testing

12.4.1.2 Military Specifications:

MIL-B-131	Barrier Materials, Watervaporproof, Greaseproof, Flexible, Heat-Sealable
MIL-P-3420	Packaging Materials, Volatile Corrosion Inhibitor Treated, Opaque
MIL-P-23236	Paint Coating Systems, Steel Ship Tank, Fuel and Salt Water Ballast
DOD-C-24176	Cement, Epoxy, Metal Repair and Hull Smoothing (metric)
MIL-P-24441	Paint, Epoxy-Polyamide, General Specification for

MIL-C-83286	Coating. Polyurethane, Aliphatic, Weather Resistant, White (Fed. Std. Color 17875)

12.4.1.3 Military Standard:

MIL-STD-101	Color Code for Pipelines and for Compressed Gas Cylinders

12.4.1.4 Air Force Manuals and Regulations:

AFM 85-3	Paints and Protective Coatings
AFM 85-16	Maintenance of Petroleum Systems

12.4.1.5 Steel Structures Painting Council (SSPC) Publications.

SSPC-SP 10	Near White Blast Cleaning
SSPC-Guide to Vis 1	Pictorial Surface Preparation Standards for Painting Steel Surfaces

12.4.1.6 National Association of Corrosion Engineers (NACE Publication:

Coating and Lining for Immersion Services, Chapter 4,

Inspection:

Condition "A" - Pinhole Free

Condition "B" - Relatively Pinhole Free

12.4.2 COATING SYSTEM DESCRIPTION-AREAS TO BE COATED. See 12.4.13 for specific areas to be coated for various tank configurations. For additional guidance contact command or HQ AFESC/DEMM POL Engineer. Abrasive blast steel as specified herein. The coating system shall be as specified in 12.4.10.

12.4.3 MANUFACTURER'S CERTIFICATION.

12.4.3.1 Conformance Certification. Before delivery of the coating system to the job site, submit 4 copies of

manufacturer's certificates of compliance or conformance attesting that the materials proposed for use meet the requirements specified.

12.4.3.2 Sample. Submit a 1 quart sample of each component to the government agency designated by the contracting officer.

12.4.4 APPLICABLE MATERIALS.

12.4.4.1 Primer. Epoxy-Polyamide, Green Primer, Formula 150 of MIL-P-24441.

12.4.4.2 Topcoat. Epoxy-Polyamide, White Topcoat, Formula 152 of MIL-P-24441.

12.4.4.3 Primer. Epoxy-Polyamide, Zinc Rich Primer, Formula 159 of MIL-P-24441.

12.4.4.4 Topcoat. Polyurethane Coating, White Topcoat, MIL-P-83286.

12.4.4.5 Vapor-Tight Material. MIL-B-131 or MIL-P-3420

12.4.4.6 Epoxy Cement. MIL-C-24176, Type II

12.4.4.7 Abrasives. Abrasives for blasting shall be sharp, washed, salt free angular silica sand, crushed garnet or slag, free from feldspar or other constituents that tend to break down and remain on the surface. Particle size grading shall be such that all particles will pass a No. 20 sieve and be retained on a No. 40 sieve with not less than 40 per cent retained on a No. 30 sieve.

12.4.5 COLOR MARKING. Specified FED-STD-595 color numbers apply. Piping and conduit identification shall be in accordance with MIL-STD-101. Direction of fluids shall be marked in accordance with MIL-STD-101.

12.4.6 COATING PRODUCTION, SAMPLING, AND TESTING. The coatings specified in this guide specification shall be procured from a manufacturer listed on the latest qualified products list (QPL) issued for MIL-P-24441. A copy of the test report for each batch shall be forwarded to the Contracting Officer. Specification for Formula 159 MIL-P-24441, Epoxy-Polyamide Zinc Primer is available from GSA or NAVSEA, Code O5M, Washington DC, Telephone Number 202-692-0215, AUTOVON 222-0215.

12.4.7 SAFETY. Safety requirements in AFM 85-16, Chapter 11, apply.

12.4.8 SURFACE PREPARATION - GENERAL. Rough surfaces on weld seams, sharp edges, and corners shall be ground smooth, i.e., to a minimum of a 1/8-inch radius. Abrasive-blast all surfaces to near-white metal in accordance with SSPC-SP 10. Prior to commencing blasting, prepare a 12-inch square steel test plate for conditions selected in SSPC-Guide to Vis 1. Submit the sample to the Contracting Officer. Use the approved sample test plate as a standard of comparison for the tanks surfaces throughout the course of work. Keep the test plate carefully wrapped and sealed in vapor-tight material for corrosion protection. Blasting equipment shall be conventional air, force-feed or Pressure type. Dry blasting is preferred but if required to meet environmental regulations, wet abrasive blasting may be used. For wet abrasive blasting, 2 pounds of inhibitor (mixture of 1 part sodium nitrite and 4 parts ammonium phosphate, dibasic) should be dissolved in 15 gallons

of water and added to 300 pounds of sand. For washdown of spent abrasive and corrosion products after blasting, 2 pounds of the inhibitor mixture should be dissolved in 40 gallons of water. The surface should be rinsed with-fresh water after application of the inhibitor. Coating application should be made before occurrence of flash rust (approximately 8 hours). Provide blasting equipment of such size that a pressure of 90 plus or minus 10 psig is maintained at the blast nozzle. Filter and free air supply of oil and moisture. Blast in sections or blocks small enough to permit application of the Formula 150 primer coating during the same working shift. The time interval between blasting and application of the primer coating shall not exceed 8 hours. Abrasive-blast tank surfaces as required to match the prepared test plate. After abrasive-blasting, thoroughly clean surfaces by brushing, blowing with oil-free and moisture-free compressed air or vacuuming. Sharp depressions or deep pits should be trowled smooth with epoxy cement. The cement shall have a texture sufficient to permit tight bonding of the organic coating.

12.4.9 TEMPERATURE CONDITIONS - GENERAL.

12.4.9.1 Temperature Limits. Abrasive blasting and coating operation shall be done only when the steel surface is between 35 and 100 deg. F (1.7 and 43 deg. C) and the temperature is more than 5 degrees Fahrenheit, deg. F (2.8 degree Centigrade, deg. C) above the dew point of the ambient air. This

5 deg. F (2.8 deg. C) differential is necessary to prevent condensation of moisture on the metal surface.

12.4.9.2 Environmental Enclosure. A temporary enclosure shall be provided to allow painting and abrasive blasting of the tank surfaces during inclement weather. The structure and scaffolding shall be constructed of fire retardant materials. Ventilation and heating equipment with explosion proof motors shall be provided to maintain temperatures of 60 to 80 deg. F (16 to 30 deg. C) and dew point conditions specified in section 12.4.9.1.

12.4.10 APPLICATION OF COATING SYSTEM.

12.4.10.1 General. The dry film thickness (DFT) coating system shall be as specified below. The complete coating system shall be 8 to 10 mil DFT.

1st Coat - Formula 159 Epoxy-Polyamide Zinc Rich Primer, MIL-P-24441; 2 to 4 mils DFT

2nd Coat - Formula 150 Epoxy-Polyamide Green Primer, MIL-P-24441; 2 to 4 mils DFT

3rd Coat - Formula 152 Epoxy-Polyamide White Topcoat, MIL-P-24441; 2 to 4 mils DFT

4th Coat - Polyurethane White Topcoat, MIL-P-83286; 2 to 3 mils DFT

12.4.10.2 General Procedure. Apply primer coat as soon as practicable after the abrasive blast cleaning. In no case shall the time interval exceed 8 hours. If any visible rusting does occur regardless of the time period, reblast the surface prior to applying the primer coat. The coating system shall be applied by experienced applicators. All weld seams, reinforcing beams, and sharp edge shall be brush painted before spray painting each of the first three coats of paint. The three coats of epoxy (Formula 159, Formula 150, and Formula 152) shall be applied successively allowing a drying time of not less than 16 hours nor more than 48 hours between coats for the epoxy coatings and no more than 16 hours for the MIL-P-83286 polyurethane. Each of the epoxy coats shall have a dry film thickness (DFT) from 2 to 4 mils and the polyurethane, 2 to 3 mils (DFT). The minimum DFT shall be not less than 8 mils. If necessary to obtain the required minimum thickness of 8 mils an additional topcoat shall be applied within 16 hours. 12.4.10.3 Instructions for Epoxy-Polyamide Coatings, (MIL-P-24441).

12.4.10.3.1 Coating Description. Epoxy-polyamide coatings are similar to other epoxy coatings in that they consist of a two component system that includes a pigmented polyamide resin

portion (A component) and an epoxy resin portion (B component). Once they are mixed together and applied as a paint film, the coating cures to a hard film by chemical reaction between the epoxy and polyamide resins. During this curing period, the solvents used to maintain the composition in liquid form are released by evaporation.

12.4.10.3.2 Coating Available. Epoxy-polyamide coating (MIL-P-24441) consists of individual formulations, for example, Formula 150 is for green primer, and Formula 152 is for white topcoat. These coatings are suitable for use in or on tanks, structural steel, water tanks (industrial and potable) and other high performance areas. Epoxy-polyamide coatings are available in 10-gallon, 2-gallon, and 2-quart kits, see Appendix A for list of Federal Stock Numbers.

12.4.10.3.3 Epoxy-Polyamide Coating Hazards. All MIL-P-24441 formulations have a minimum flash point of 95 deg. F (35 deg. C) and do not require the type of precautions against fire that are essential for vinyl paints. Since solvent fumes from epoxy paint systems are combustible and toxic, suitable precautions shall be taken to prevent their accumulations, particularly in confined spaces. Precautions against such hazards are contained in Chapter 3 of AFM 85-3 and in AFM 85-16. In addition to fire and toxic hazards, epoxy coatings can cause allergic reactions when allowed to come in contact with the skin. Prompt skin cleanup after contact using soap and water,

not solvent, is recommended. Solvent will thin and spread the paint over the skin, permitting deeper penetration and increasing the hazard of a delayed allergic reaction.

12.4.10.3.4 Surface Preparation. The single most important factor affecting the performance of the MIL-P-24441 epoxy-polyamide coatings is the preparation of the surface to be coated both as to method and quality of workmanship. Surfaces to be coated should be completely free from rust, loose paint, dirt, scale, oil, grease, salt deposits, moisture, and other contaminants. Surface preparation procedures detailed in 12.4.8 apply and are supplemented by requirements given below.

12.4.10.3.4.1 Old Painted Surfaces. When painted surfaces show evidence of corrosion, peeling, blistering, checking, or general disintegration, the old paint should be removed down to bare metal prior to repainting. Surfaces to be painted with the epoxy-polyamide system shall be abrasive blasted to near-white metal. In areas where abrasive blasting is not permitted, the surfaces should be cleaned by mechanical means (disk sanding, chipping tools, or pneumatic descaler (needle gun)), to remove all loose paint film and foreign matter. Since abrasive blasting will not adequately clean surfaces contaminated with oil or grease, such areas should be cleaned with solvent prior to abrasive blasting.

12.4.10.3.4.2 Surface Preparation of Coated Metal. Brush abrasive blasting of the coating may be used instead of blasting to bare metal in those instances where an epoxy coating is in good condition and is well-bonded. This method should result in a surface retaining all satisfactory paint films, but free from all rust, scale and foreign matter that would inhibit bonding of a topcoat.

12.4.10.3.5 Touch-up Painting. When only localized damaged areas or spots require painting, it is essential that removal of the deteriorated paint be carried back to an area of completely intact and tightly adhering paint film. Edges of tightly adhering paint remaining around the area to be recoated shall be sanded to a smooth slope (feathered) from the intact paint film to the bare metal area. Areas of intact paint to be overcoated shall first be roughened by light abrasive blasting or hand sanding. A tack coat shall then be applied and allowed to remain 4 hours before applying the full coat.

12.4.10.3.6 Mixing Epoxy-polyamide Coatings. Epoxy-polyamide coatings are supplied in measured amounts that must be mixed together in exact proportions to ensure the correct and complete chemical reaction. Mix no more paint than can be applied in the same day. The estimated pot life is 3-4 hours for 5 gallons at 70-80 deg. F. Discard any mixed paint remaining at the end of the day.

12.4.10.3.6.1 Mixing Ratio. The mixing ratios of the MIL-P-24441 coatings (except Formula 159) are all 1:1 by volume; for example, 5 gallons of component A to 5 gallons to component B.

NOTE: The individual A and B components of the various formulas are not interchangeable.

12.4.10.3.6.2 Mixing Procedures. Each component shall be thoroughly stirred prior to mixing the components together. After mixing equal volumes of the two components, this mixture shall again be thoroughly stirred until well blended. The induction time shall be adhered to, to ensure complete chemical reactions. Induction time is defined as the time immediately following the mixing together of components A and B during which the critical chemical reaction period of these components is initiated until the mixture is ready for application. This reaction period is essential to ensure the complete curing of the coating. Volumetric mixing spray equipment with in-line heaters set at 70 to 80 deg. F (21 to 28 deg. C) may be used without an induction period.

12.4.10.3.7. MIL-P-24441 Induction Times. The temperature of the paint components in storage should be measured to determine induction time and the pot life. Pot life is the usable life of the mixed paint. It is dependent upon the temperature and the volume of the mixed paint. The pot life of a five gallon mixture of the MIL-P-24441 paints at 70-80 deg. F is approximately 4 hours. The job site application temperature will affect the time required for the paint to cure, and must be considered in estimating induction time, cure time, and the effect of batch size on these functions. At 40

to 60 deg. F a 1 hour induction time shall be used. Volumetric mixing spray equipment with in-line heaters set at 70 to 80 deg. F may be used without an induction period. To ensure that the reaction proceeds uniformly, the paint should be manually stirred periodically during its induction period. This prevents localized overheating or hot spots within the paint mixture.

12.4.10.3.8 Epoxy-Polyamide Coating Application. Epoxy-polyamide coatings, MIL-P-24441, may be applied by brushing, spraying, or dip application.

12.4.10.3.8.1 Thinning Application. Ordinarily, MIL-P-24441 coating are not thinned. If necessary, up to one pint of epoxy thinner for each gallon of mixed paint may be added if paint has thickened appreciably during cold temperature application or if necessary to improve application characteristics. When applied at the proper thicknesses, without thinning, these paints will have no tendency to sag.

12.4.10.3.8.2 Application Thickness. Unless otherwise specified, apply each coat of paint to produce approximately 3 mils dry film thickness (DFT). Application which yields in excess of 4.0 mils DFT should be avoided to prevent sagging.

12.4.10.3.8.3 Spray Application. MIL-P-24441 paints should be sprayed with the conventional spray guns and normal spray-pot pressures. The spray gun should be equipped with a middle-size

(D) needle, and nozzle setup. Both conventional and airless spray equipment are suitable for use with or without volumetric mixing capability.

12.4.10.3.9 Tack Coat for MIL-C-83286 Polyurethane Topcoat. Application of the polyurethane topcoat MIL-C-83286 shall be made after the third coat of the epoxy (Formula 152) has cured thoroughly (8 to 16 hours depending on ambient temperature). If the epoxy coating cures for more than 16 hours, a tack or mist coat of 1 to 2 mils wet film thickness (WFT) must be applied and dried 8 hours before applying the topcoat. The tack coat should be the same material as the preceding coat of the epoxy. If more than 7 days elapse since the last coat of epoxy, the surface shall be cleaned with water and detergent and rinsed clean with fresh water. If required, use solvents for grease and oil removal. Then a tack coat (1 to 2 mils WFT) of the last coat applied, or Formula 150, should be reapplied to the cured coat and allowed to dry approximately 4 hours before application of the polyurethane topcoat (12.4.10.4).

12.4.10.3.10 Equipment Cleanup. Since epoxy paints cure by internal chemical reaction, the mixed paint should not be llowed to remain in spray equipment for an extended period, especially in the sun or a warm area. The paint cures more rapidly at higher temperatures. When components A and B are mixed together, the pot life of the mixture (including the

induction time) is 6 hours at 70 deg. F (21 deg. C). Pot life is longer at lower temperatures and shorter at temperatures above 70 deg. F (21 deg. C). Spray equipment should be cleaned after using by flushing and washing with epoxy thinner or aromatic hydrocarbon thinners (xylene or high flash aromatic naptha). General cleanup is also done by using these solvents. Brushes and rollers should be given a final cleaning in warm soapy water, rinsed clean with warm fresh water, and hung to dry.

12.4.10.4 Application of Polyurethane Coating, (MIL-C-83286). Apply in accordance with MIL-C-81907.

12.4.11 FIELD TEST AND INSPECTION

12.4.11.1 General. To ensure proper inspection, the contractor shall advise the Contracting Officer when the work in progress is at the various steps listed below:

Step	Action
Prior to preparation of tank(s) for cleaning and repair	Safety inspection as specified in 12.4.6
After cleaning of tank(s) and prior to abrasive blasting	Safety inspection, removal of dirt, trash, debris, and any hindrance to abrasive blasting
After abrasive blasting	Surface inspection for coating application specified in 12.4.10

Step	Action
During and after coating application	Coating application inspection as specified in 12.4.10 and 12.4.11.2
After final cleanup	Cleanup inspection specified in 12.4.12

12.4.11.2 Final Inspection. Following completion and cure oœ the coating system, the surfaces shall be carefully inspected by the contractor for pinholes, blisters, inadequate coating thickness, and other defects. All imperfections found that deviate from the specification shall be repaired by the contractor. The dry film thickness shall be measured by the contractor using a calibrated magnetic gage at 10 equally spaced points within a 10-foot by 10-foot area as designated. The highest and lowest values shall be discarded and an average of the remaining eight values shall be taken as the coating thickness. If the average is less than the specified minimum dry film thickness, additional readings shall be taken in adjacent areas to define the extent of the thin area. Such areas shall be recoated with the white polyurethane topcoat as necessary to achieve the specified thickness. The recoating shall be within the time period specified in 12.4.10.2. Any coated areas that exceed 48 hours shall be lightly brush blasted or hand sanded to remove the glossy surface before

applying the additional topcoat. The coating system shall be inspected for film imperfections using a low voltage (75 volts direct current (VDC) less) wet sponge holiday detector or an approximately 1440 VDC volt detector with a conductive silicone brush electrode. A distinctly audible signal on these detectors shall sound to indicate imperfections caused by current flowing through the coating to the base metal. Imperfections shall be touched up. No holidays or pinholes shall be allowed over welds and over the roof area, and these areas shall conform to NACE Condition "A" (reference 12.4.1.5). All other areas shall conform to Condition "B" to "A" with Condition "B" defined as no more than one point of discontinuity in any 10 square foot area. After the work has been inspected and approved, the tank shall be fill tested.

12.4.12 FINAL CLEANUP. Following completion of the work, the contractor shall remove all debris, equipment, and materials from the site. Temporary connections to Government furnished water and electrical services shall be removed. All existing facilities in and around the work areas shall be restored to their original condition.

12.4.13 NOTE. (This section should not be included in contract specification.)

12.4.13.1 AREAS TO BE COATED. Selection of areas to be coated (see 12.4.2) should be completed by the cognizant base engineer. It should state specific exterior tank areas to be coated based on inspection of the actual tank, its drawings,

and specifications. All exterior steel piping, valves, fixed steel roofs, and floating steel roofs should be coated. Do not coat floating or fixed aluminum roofs.

Section 5

SPECIFICATION FOR COATING SYSTEM FOR STEEL STRUCTURES AND GALVANIZE REPAIR

12.5.1 APPLICABLE PUBLICATIONS. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

12.5.1.1 Federal Standard.

Color (Requirement for individual color chips)
Fed Std 595

12.5.1.2 Military Specifications.

MIL-P-24441	Paint, Epoxy-Polyamide, General Specification for
MIL-C-24176	Cement, Epoxy Metal Repair and Hull Smoothing

12.5.1.3 Air Force Manuals and Regulations.

AFM 85-3	Paints and Protective Coatings
AFM 85-16	Maintenance of Petroleum Systems
AFR 127-12	Air Force Occupational Safety and Health Program.

12.5.1.4 Federal Regulations.

OSHA	Occupational Safety and Health Act

12.5.1.5 Steel Structures Painting Council (SSPC) Publications.

SSPC-SP 10	Near White Metal Blast
SSPC-Guide to Vis 1	Pictorial Surface Preparation Standards for Painting Steel Surfaces

12.5.1.6 National Association of Corrosion Engineers (NACE) Publications.
Coating and Lining for Immersion Services, Chapter 4, Inspection.

12.5.1.7 Technical Manuals.
Naval Ships Technical Manual, Chapter 631 Preservation of Ships in Service (Surface Preparation and Painting) NAVSEA S9086-VD-STM-000/Ch-631.

12.5.2 COATING SYSTEM DESCRIPTION. Navy Formula 159 epoxy-polyamide zinc coating specified in MIL-P-24441 is a two component, high solids, high zinc content coating. This coating may be used as a complete protective system or as part of a multi-coat system to provide a "permanent" primer that can provide cathodic protection to steel equivalent to galvanize. It is extremely effective in preventing corrosion attack on steel surfaces and repairing galvanized surfaces. Although it can provide effective cathodic protection, it also has excellent compatibility with most topcoats. This is a characteristic not found with other types of zinc coatings.

12.5.2.1 EPOXY-POLYAMIDE ZINC AS A TOTAL COATING SYSTEM. One or two coats of Formula 159 applied at 2-3 mls DFT per coat may be used in environments high in humidity, moisture, sunlight, high temperature (up to 600 deg. F) and high abrasion. Areas of use include structures in splash zones, walkways, exterior of tanks, hangar doors, and support structures, structural steel towers, foundations and metal siding, petroleum product service, and steel and galvanized areas that cannot be sandblasted.

12.5.2.2 PERMANENT PRIMER. Formula 159 is well suited for use as a rust preventing primer because of its good adhesion, cathodic protection, ease of application, and compatibility with most industrial maintenance topcoats. Formula 159 may be used as a shop coat or preconstruction primer. It dries quickly and is resistant to handling and transportation damage. It can be used for quick repair of damaged or severely weathered galvanize. For areas cited in 12.5.2.1 that may require topcoating, Formula 159 may be topcoated directly with epoxies, acrylic emulsion paints, or polyurethanes. Vinyl or chlorinated rubber topcoats should be applied after application of a vinyl wash primer, MIL-P-15328. Oil base coatings are not recommended for overcoating of Formula 159. However, alkyd systems like TT-P-489 or TT-E-490 may be applied over Formula 159 if a tie coat of Formula 150 or Formula 151 is used. The coating systems shall be as specified in 12.5.10.1.

12.5.3 MANUFACTURER'S CERTIFICATION.

12.5.3.1 Conformance Certification. Before delivery of the coating system to the job site, submit 4 copies of the manufacturer's certificates of compliance or conformance attesting that the materials proposed for use meet the requirements specified. The Government reserves the right to perform any of the inspection set forth in this specification where such inspections are deemed necessary to assure supplies and services confirm to prescribed requirements.

12.5.3.2 Samples. Submit a 1 quart sample of each component to the Government agency designated by the contracting officer.

12.5.4 APPLICABLE MATERIALS. Epoxy-Polyamide, Zinc, Primer, MIL-P-24441, Formula 159 Type II and attached Military specification Sheet.

12.5.5 COLOR. The color of the primer shall be gray, typical of the ingredients used in the formula. Top coat colors should be specified from Fed Std 595.

12.5.6 COATING PRODUCTION, SAMPLING AND TESTING. The coating specified in this guide specification shall be procured from a manufacturer listed on the latest Qualified Products List (QPL) issued for MIL-P-24441. A copy of the test report for each batch shall be forwarded to the contracting officer.

12.5.7 SAFETY. Safety requirements in AFOSH standards, OSHA regulations and state and local regulations shall apply.

12.5.8 SURFACE PREPARATION--GENERAL. Abrasive blasting to near white metal as specified in SSPC-SP 10 is the preferred method and provides the best surface for performance of the Formula 159 coating both as a permanent primer or coating system. Hand power tools, hand wire brushes or other tools may be used for preparing painted steel surfaces for touch-up or for preparation of areas where abrasive flashing is prohibited.

12.5.8.1 Abrasive Blasting Steel Surfaces. Rough surfaces on weld seams, sharp edges, and corners shall be ground smooth to a minimum of a 1/8-inch radius. Abrasive-blast all surfaces to a near white metal in accordance with SSPC-SP 10. Prior to commencing blasting, prepare a 12-inch square steel test plate for conditions selected in SSPC-Guide to Vis 1. Submit the sample to the Contracting Officer. Use the approval sample test plate as a standard of comparison for the tanks surfaces

throughout the course of work. Keep the test plate carefully wrapped and sealed in vapor-tight material for corrosion protection. Blasting equipment shall be conventional air, force-feed or pressure type. Dry blasting is preferred but if required to meet environmental regulations, wet sandblasting may be used. For wet abrasive blasting, 2 pounds of inhibitor (mixture of 1 part sodium nitrite and 4 parts ammonium phosphate, dibasic) should be dissolved in 15 gallons of water and added to 300 pounds of sand. For washdown of spent abrasive and corrosion products after blasting, 2 pounds of the inhibitor mixture should be dissolved in 40 gallons of water. The surface should be rinsed with fresh water after application of the hibitor. Coating application should be made before occurrence of flash rust (approximately 8 hours). Provide blasting equipment of such size that a pressure of 90 +/- 10 psig is maintained at the blast nozzle. Filter air supply to eliminate oil and moisture. Blast sections or blocks small enough to permit application of the Formula 159 primer coating during the same working shift. The time interval between blasting and application of the primer coating shall not exceed 8 hours. Abrasive-blast surfaces as required to match the prepared test plate. After abrasive-blasting, thoroughly clean surfaces as required to match the prepared test plate. After abrasive-blasting, thoroughly clean surfaces by brushing, blowing with oil-free and moisture-free compressed air or vacuuming. Sharp depressions or deep pits should be trowled smooth with epoxy cement MIL-C-24176. The cement shall have a texture sufficient for tight bonding of the organic coating.

12.5.9 TEMPERATURE CONDITIONS--GENERAL.

12.5.9.1 Temperature Limits. Abrasive blasting and coating operations shall be done only when the steel surface temperature is more than 5 degrees Fahrenheit, deg. F (2.8 degree Centigrade, deg. C) above the dew-point of the ambient air. This 5 degree F (2.8 deg. C) differential is necessary to prevent condensation of moisture on the metal surface. Coating application shall be done only when the ambient temperature is between 40 and 90 deg. F (22 and 50 deg. C).

12.5.9.2 Environmental Enclosure. A temporary enclosure shall be provided to allow painting and sandblasting of steel surfaces during inclement weather. The structure and scaffolding shall be constructed of fire retardant materials. Ventilation and heating equipment with explosion-proof motors shall be provided to maintain temperatures of 60 to 80 deg. F (16 to 30 deg. C) and dew point conditions specified in 12.5.9.1.

12.5.10 APPLICATION OF COATING SYSTEMS.

12.5.10.1 General. The following coating systems shall be as specified below. See Notes in 12.5.13 for guidance for use of the listed coating systems. Each complete coating system shall be as specified below applied at the dry film thickness (DFT) specified.

12.5.10.1.1 Preconstruction or Shop Coat. Apply to abrasive blasted steel parts, plates, structural components, or structures that may be coated later with complete system.

1 Coat	Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

12.5.10.1.2 Galvanize Repair or Galvanize Replacement. Apply to abrasive blasted or hand tool cleaned surfaces as complete

coating system where topcoats are not required.

1 Coat Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

2 Coat Formula 159, MIL-P-24441 Epoxy-polyamide zinc coating, 2 to 4 mils DFT.

Total DFT of coating system - 4 to 6 mls.

12.5.10.1.3 Permanent Primer Systems. Apply to abrasive blasted steel or galvanized surfaces.

12.5.10.1.3.1 Epoxy System.

1 Coat Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

2 Coat Formula 150, MIL-P-24441 Epoxy-polyamide green primer, 2 to 4 mls DFT.

3 Coat Formula 152, MIL-P-24441, Epoxy-polyamide white top, 2 to 4 mls DFT.

Total DFT of coating system - 8 to 12 mls.

12.5.10.1.3.2 Polyurethane Topcoat System. Apply to abrasive blasted steel or abrasive blasted galvanize surfaces.

1 Coat Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

2 Coat Formula 150, MIL-P-24441 Epoxy-polyamide green primer, 2 to 4 mls DFT.

3 Coat MIL-C-83286, Coating, Urethane, Aliphatic Isocyanate, 2 to 4 mls DFT.

Total DFT of coating system - 8 to 12 mls.

12.5.10.1.3.3 Vinyl System. Apply to abrasive blasted steel or abrasive blasted galvanized surfaces.

1 Coat Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

2 Coat MIL-C-15328, Vinyl wash primer; 0.5 to 0.7 ml DFT.

3 Coat SSPC Paint No. 9, Primer Coating Vinyl Paint, light gray (Fed Std 595 Color No. 26622), 2 to 3 mls DFT.

4 Coat SSPC Paint No. 9 Vinyl Paint; 2 to 3 DFT.

Total DFT of coating system - 6 to 8 mls.

12.5.10.1.3.4 Chlorinated Rubber System.

1 Coat Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

2 Coat TT-P-95 Type 1, chlorinated rubber coating, 2 4 mls DFT.

3 Coat TT-P-95 Type 1, chlorinated rubber coating, 2 4 mls DFT.

Total DFT of coating system - 6 to 8 mls.

12.5.10.1.3.5 Acrylic Emulsion System.

1 Coat Formula 159, MIL-P-24441, Epoxy-polyamide zinc coating, 2 to 4 mls DFT.

2 Coat TT-P-19, Acrylic Emulsion Exterior Paint, 1 to 3 mls DFT.

3 Coat TT-P-19, Acrylic Emulsion Exterior Paint, 1 to 3 mls DFT.

Total DFT of coating system - 5 to 7 mls.

12.5.10.2 Instructions for Epoxy-Polyamide Zinc Coating, (MIL-P-24441) Formula 159:

12.5.10.2.1 Coating Descrtiption. Formula 159 epoxy-polyamide zinc coating is similar to other epoxy coatings in that it consists of a two component system that includes a polyamide resin component (A component) and an epoxy resin component (B component). Once they are mixed together and applied as a paint film, the coating cures to a hard film by chemical reaction between the epoxy and polyamide resins. During this curing period, the solvents used to maintain the composition in liquid form are released by evaporation.

12.5.10.2.2 Coatings Available. Epoxy-Polyamide coatings (MIL-P-24441) consist of individual formulations, for example, Formula 150 is for green primer, and Formula 152 is for white top coat. These coatings are suitable for use in or on tanks, structural steel, water tanks (industrial and potable) and other high performance areas. Epoxy-polyamide coatngs are available in 10-gallon, 2-gallon, and 2-quart kits. The MIL-P-24441 coatings are available from manufacturers on the QPL or from the Federal Supply System. Appendix A contains a list of the Federal Stock Numbers for these coatings.

12.5.10.2.3 Epoxy-Polyamide Coating Hazards. All MIL-P-24441 Formulations have a minimum flash point of 95 deg. F (35 deg. C) and do not require the type of precautions against fire that are essential for vinyl paints. Since solvent fumes from epoxy paint systems are combustible and toxic, suitable precautions shall be taken to prevent their accumulation, particularly in confined spaces. Precautions against such hazards are contained in chapter 3 of AFM 85-3 and in AFM 85-16. In

addition to fire and vapor hazards, epoxy coatings can cause allergic reactions when allowed to come in contact with the skin. Prompt skin cleanup after contact is recommended using soap and water. Solvent is not recommended. Solvent will thin and spread the paint over the skin, permitting deeper penetration and increasing the hazard of a delayed allergic reaction.

12.5.10.2.4 Surface Preparation. The single factor most affecting the performance of the MIL-P-24441 epoxy polyamide coatings is the preparation of the surface to be coated both as to method and quality of workmanship. Surfaces to be coated should be completely free from rust, loose paint, dirt, scale, oil, grease, salt deposits, moisture, and other contaminants. Surface preparation procedures detailed in 12.5.8 apply and are supplemented by requirements below.

12.5.10.2.4.1 Old Painted Surfaces. When painted surfaces show evidence of corrosion, peeling, blistering, checking, or general disintegration, the old paint should be removed down to bare metal prior to repainting. Surfaces to be painted with the epoxy-polyamide system shall be abrasive blasted to near-white metal. In areas where abrasive blasting is not permitted, the surfacs should be cleaned by mechanical means (disk sanding, chipping tools, or pneumatic descaler (needle gun)), to remove all loose paint film and foreign matter. Since abrasive blasting will not adequately clean surfaces contaminated with oil or grease, such areas should be cleaned with solvent prior to abrasive blasting.

12.5.10.2.4.2 Galvanized Steel. Galvanized steel should be acid etched with 10 percent phosphoric acid to achieve a textured surface for good bonding, rinsed with clean water, dried and roughened by a light abrasive blast or by mechanical means to remove rust to provide a suitable painting surface.

12.5.10.2.5 Touch-Up Painting. The epoxy-polyamide zinc coating Formula 159 is very effective for touching-up and repair application. It has excellect adhesion to a wide variety of surfacs including smooth steel, hand prepared or abrasive blasted steel, galvanized steel, epoxy coatings, alkyd coatings, vinyl coatings, inorganic zinc coatings, or aged and weathered organic zinc coatings. Touch-up and repair should be limiated to 15-20% of the total area. If the area exceeds this amount, total removal and replacement of the existing coating should be considered. Preparation of steel or galvanized surfaces for touch-up repair should be accomplished by removal of existing coatings and corrosion to clean bare metal. This may be accomplished by light abrasive or hand power tool or hand sanding. The adjacent coating should be lightly roughened to promote adhesion. Application of Formula 159 may be by brush or spray. Eight (8) to sixteen (16) hours of curing should be allowed before overcoating.

12.5.10.2.6 Mixing Epoxy-Polyamide Coatings. Epoxy-polyamide coatings are supplied in measured amounts that must be mixed together in exact proportions to ensure the correct and Complete chemical reaction. Mix no more paint than can be applied the same day and discard any mixed paint remaining at the end of the day.

12.5.10.2.6.1 Mixing Ratio. The mixing ratio of the MIL-P-24441 Formula 159 is 1:4 by volume; for example, four gallons of component A to one gallon of component B. Other MIL-P-24441 formulas are mixed one to one (1:1) by volume.

NOTE: The individual A and B components of the various formulas are not interchangeable.

12.5.10.2.6.2 Mixing Procedures. Each component shall be thoroughly stirred prior to mixing the components together. After mixing of the two components, this mixture shall be thoroughly stirred until well blended. The induction time shall be adhered to. Induction time is defined as the time immediately following the mixing together of components A and B during which the critical chemical reaction period of these components is initiated until the mixture is ready for application. This reaction period is essential to ensure the complete curing of the coating. Volumetric mixing spray equipment with in-line heaters set at 70 to 80 deg. F (21 to 28 deg. C) may be used without an induction period.

12.5.10.2.7 MIL-P-24441 Induction Times. The approximate temperature of the paint components in storage should be estimated to judge the amount of induction time and the pot life that might be expected (Pot life is the usable time period at a given temperature). The job site application temperature will affect the time required for the paint to cure, and must be considered in estimating induction time, cure time, and the effect of batch size on these functions. At 40 to 60 deg. F (4.4 to 16 deg. C) at 1-hour induction time shall be used. Volumetric mixing spray equipment with in-line heaters set at 70 to 80 deg. F (21 to 28 deg. C)

may be used without an induction period. To ensure that the reaction proceeds uniformly, the paint should be manually stirred periodically during its induction period. This prevents localized overheating or hot spots within the paint mixture.

12.5.10.2.8 Epoxy-Polyamide Coating Application. Epoxy-polyamide coatings, MIL-P-24441, may be applied by brushing, spraying, or dip application.

12.5.10.2.8.1 Thinning Application. Ordinarily, MIL-P-24441 coatings are not thinned. If necessary, up to 1 pint of epoxy thinner for each gallon of mixed paint may be added if the paint has thickened appreciably during cold temperatures or if necessary to improve application charcteristics. When applied at the proper thicknesses, without thinning, these paints will have no tenency to sag.

12.5.10.2.8.2 Application Thickness. Unless otherwise specified, apply each coat of Formula 159 to produce approximately 3 mils dry film thickness (DFT). Application which yields in excess of 4.0 mils DFT should be avoided to prevent sagging.

12.5.10.2.8.3 Spray Application. MIL-P-24441 paints should be sprayed with the conventional spray guns and normal spray-pot pressures. The spray gun should be equipped with a middle-size (d) needle, and nozzle setup. Both conventional and airless spray equipment are suitable for use with or without volumetric mixing capability.

12.5.10.2.9 Equipment Cleanup. Since Formula 159 cures with time by chemical reaction, the mixed paint should not be allowed to remain in spray equipment for an extended period,

especially in the sun or a warm area. The paint cures more rapidly at higher temperatures. When components A and B are mixed together, the pot life of the mixture (including the induction time) is 6 hours at 70 deg. F (21 deg. D). Pot life is longer at lower temperatures and shorter at temperatures above 70 deg. F (21 deg. C). Spray equipment should be cleaned after using by flushing and washing with epoxy thinner or aromatic hydrocarbon thinners (xylene or high flash aromatic naptha). General cleanup is also done by using these solvents. Brushes and roller should be given a final cleaning in warm soapy water, rinsed clean with warm fresh water, and hung to dry.

12.5.11. FIELD TEST AND INSPECTION

12.5.11.1 General. To ensure proper inspection, the contractor shall advise the Contracting Officer when the work in progress is at the various steps listed below:

Step	Action
Prior to preparation of steel surfaces for cleaning and repair	Safety inspection specified in 12.7.6.
After cleaning of surfaces and prior to abrasive blasting.	Safety inspection, removal of dirt, trash debris, and any hindrance to abrasive blasting
After abrasive blasting.	Surface inspection for coating application specified in 12.7.10
During and after coating application.	Coating application inspection specified in 12.6.10 and 12.7.11.2.

After final cleanup. Cleanup inspection 12.7.12.

12.5.11.2 Final Inspection. Following completion and cure of the coating system, the surfacs shall be carefully inspected by the contractor for pinholes, blisters, inadequate coating thickness, and other defects. All imperfections found that deviate from the specification shall be repaired by the contractor using a calibrated magnetic gage at 10 equally spaced points within a 10-foot by 10-foot area as designated. The highest and lowest values shall be taken as the coating thickness. If the average is less than the specified minimum dry film thickness, additional readings shall be taken in adjacent areas to define the extent of the thin area. Coating as necessary to achieve the specified thickness. The recoating shall be within the time period specified in 12.7.10.

12.5.12 FINAL CLEANUP. Following completion of the work, the contractor shall remove all debris, equipment, and materials from the site. Temporary connections to Government furnished water and electrical services shall be removed. All existing facilities in and around the work areas shall be restored to their original condition.

12.5.13 NOTES. (This section shall not be included in contract specifications).

12.13.1 Coating systems in section 12.5.10.1 should be used as follows.

12.13.1.1 Preconstruction Primer or Shop Coat (12.15.10.11).

Coating may be used to preserve abrasive blasted steel surfaces during fabrication procedures. Damaged or burned areas should be repaired by abrasive blasting or hand power tool cleaning and then touched up with formula 159. After removal of any surface contamination the total surface can be overcoated with the specified systems.

12.13.1.2 Galvenize Repair or Galvenize Replacement (12.5.10.1.2) Formula 159 may be used to repair or coat new, weathered or corroded galvenize. Galvenize surface should be washed with freshwater, then a dilute (5%) solution of phosphoric of hydrochloric acid until corrosion or white salts are removed, rinsed with freshwater, dried, and then coated with 2 coats of Formula 159 or Formula 159 and selected topcoat(s).

12.13.1.3 Permanent Primer Systems (12.5.10.1.3). Formula 159 may be applied to abrasive blasted, steel as a permanent primer under epoxy, polyurethane, vinyl, chlorinated rubber and acrylic emulsion paints. Spot touch of coating system should be made when corrosion or film deterioration occurs. With this procedure total system can be maintained with minimum surface preparation.

APPENDIX A

NATIONAL STOCK NUMBERS (NSN)
MIL-P-24441 COATINGS

Formula	Description	NSN	Size Container
150	Green Primer	8010-00-922-1154	2-quart kit
		8010-00-410-8452	2-gallon kit
		8010-00-437-6757	10-gallon kit
151	Haze Gray Top Coat	8010-00-922-1155	2-quart kit
		8010-00-410-8458	2-gallon kit
		8010-00-410-8460	10-gallon kit
152	White Topcoat	8010-00-922-1156	2-quart kit
		8010-00-410-8461	2-gallon ki
		8010-00-421-2435	10-gallon kit
153	Black Topcoat	8010-00-922-1157	2-quart kit
		8010-00-410-8463	2-gallon kit
		8010-00-410-8464	10-gallon kit
154	Dark Gray Topcoat	8010-00-922-1158	2-quart kit
		8010-00-410-8465	2-gallon kit
		8010-00-410-8467	10-gallon kit
155	Dark Gray Topcoat	8010-00-922-1159	2-quart kit
		8010-00-410-8469	10-gallon kit
156	Red Topcoat	8010-00-922-1160	2-quart kit
		8010-00-410-8470	2-gallon kit
		8010-00-410-8471	10-gallon kit
159	Epoxy Zinc Primer	NSN Stock Numbers available from GSA or Mr John Tock NAVSEA 05M, AUTOVON 222-0215	

ETL Number	Title	Date Issued
84-2	Computer Energy Analysis Supersedes ETL 83-5 Change 1 Ref: HQ USAF/LEEEU Msg 031600Z May 84	27 Mar 84 1 Jun 84
84-3	AF Petroleum Fuel Facility Criteria and Standards Supersedes ETL 83-2	21 Mar 84
84-4	Meters in New Facilities	10 Apr 84
84-5	Heat Distribution Systems Outside of Buildings	7 May 84
84-6	Cancelled/Not Used	Not Issued
84-7	MCP Energy Conservation Investment Program (ECIP)	12 Jun 84
84-8	Heat Distribution Systems Outside of Buildings Supersedes ETL 84-5	19 Jun 84
84-9	TEMPEST/EMP Shielding for Facilities	5 Jul 84
84-10	Air Force Building Construction and the Use of Termiticides	1 Aug 84
86-1	Energy Budge Figures Supersedes ETL 83-10	3 Feb 86
86-2	Energy Management and Control Systems (EMCS)	5 Feb 86
86-3	Paints and Protective Coatings Superseded by ETL 86-4	21 Feb 86
86-4	Paints and Protective Coatings Supersedes ETL 86-3	12 May 1986